

# LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Medicine Lodge River Watershed

Water Quality Impairment: Sulfate

Replaces Upper Medicine Lodge and Lower Medicine Lodge River Sulfate TMDLs

## 1. INTRODUCTION AND PROBLEM IDENTIFICATION

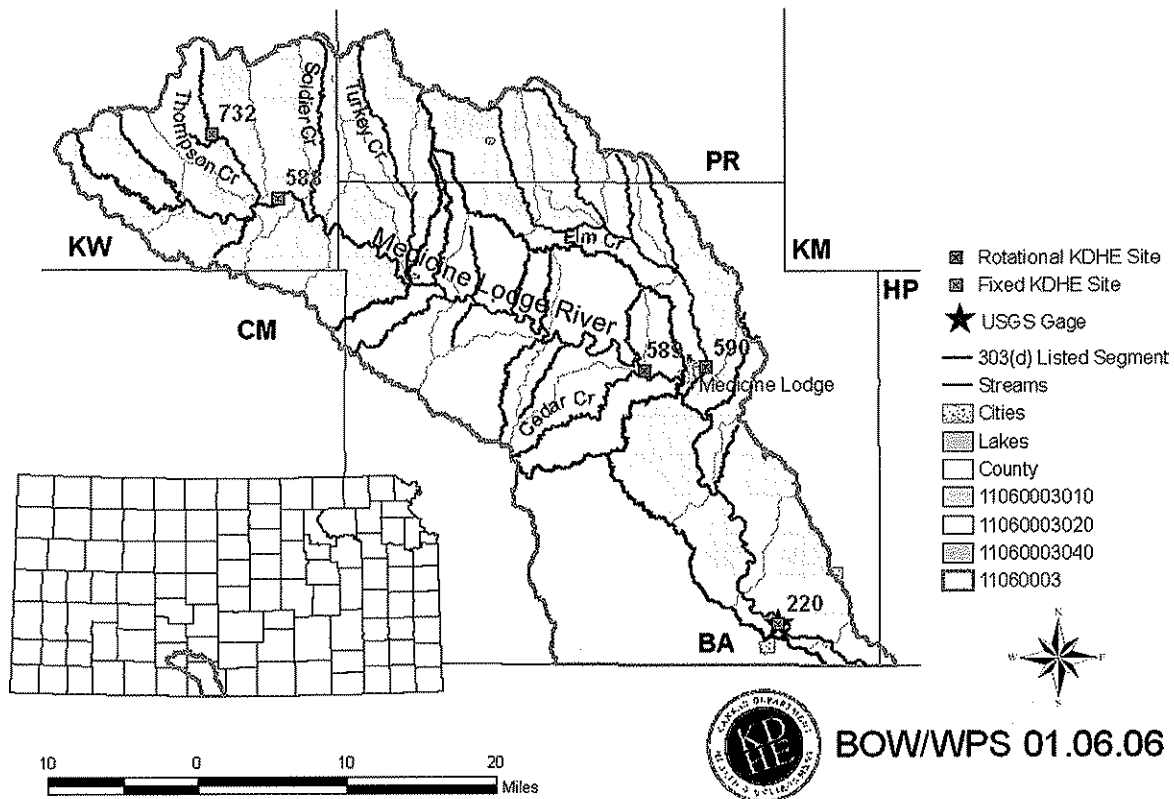
Subbasin: Medicine Lodge

Counties: Barber, Comanche, Kiowa, Harper and Pratt

HUC 8: 11060003 (Figure 1)

HUC 11 (HUC 14s):  
010 (010, 020, 030, 040, 050, 080)  
020 (010, 020, 030, 040, and 050)  
040 (050, 060, 070, 080)

## Medicine Lodge River TMDL



(Figure 1- The Medicine Lodge River Watershed)

**Ecoregion:** IV Great Plains Grass and Shrublands - 26: Southwestern Tablelands – a: Cimarron Breaks and b: Flat Tablelands and Valleys

**Drainage Area:** 965 square miles upstream from the Kansas/Oklahoma border

**Main Stem Segment:** WQLS: 2, 6, 8; starting at the Oklahoma border; Headwaters near Greensburg, in Kiowa County.

**Tributary Segments:** As identified in Table 1.

**Table 1: Tributary Segments**

Station	Main Stem Segment	Stream Name	Segment Code
220	Medicine Lodge River (2)*	Wilson Slough	23*
		Antelope Cr	22*
590	Medicine Lodge River (2)*	Elm Cr	3
		Amber Cr	12
		Crooked Cr	11
		Elm Cr, North	4
		Elm Cr, South	5
		Elm Cr, South E Br	10
589	Medicine Lodge River (6)*	Cedar Cr	20*
		Unnamed Stream	370*
		Bitter Cr	18*
		Little Bear Cr	19*
		Sand Cr	17*
		Unnamed Stream	415*
		Puckett Cr	15*
		Cottonwood Cr	16*
		Bear Cr	13*
		Mulberry Cr	14*
		Turkey Cr	7
		Soldier Cr	27
588	Medicine Lodge River (8)*	Unnamed Stream	559
		Unnamed Stream	452*
		Medicine Lodge R, N Br	24*
		Otter Cr	25*
732	Medicine Lodge River (8)*	Thompson Cr	26

\*- Sulfate impairment

**Designated Uses:** Thompson Creek is an Exceptional State Water.

Domestic Water Supply for Medicine Lodge River, North Branch Medicine Lodge River, Elm Creek, North and South Branch Elm Creek, and Thompson Creek.

Special Aquatic Life for Amber, Elm, North and South Branch Elm, Mulberry, Soldier, Thompson, Soldier, the unnamed tributaries and the main stem of the Medicine Lodge River.

Primary Contact B Recreation on Elm Creek, Primary Contact C Recreation on Medicine Lodge and Secondary Contact b Recreation on other tributaries.

**303d Listing:** 1996, 1998, 2002, and 2004 Lists

**Impaired Use:** Attainable Domestic Water Supply

**Water Quality Standard:** 250 mg/l for Domestic Water Supply (KAR 28-16-28e(c) (3) (A))

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the water quality criteria listed in Table 1a, at ambient flow, due to intrusion of mineralized groundwater, the existing water quality shall be maintained, and the newly established numeric criteria shall be the background concentration, as defined in KAR 28-16-28b(e). Background concentrations shall be established using the methods outlined in the "Kansas implementation procedures: surface water quality standards," as defined in K.A.R. 28-16-28b (gg)... dated June 1, 1999. (KAR 28-16-28e (c) (3) (B)).

**Table 2: Natural Background Concentrations (Table 1b of Tables of Numeric Criteria – K.A.R. 28-16 (d) (e))**

Station	Stream	Concentration
220	Medicine Lodge River Reach 2	450 mg/l (Adopted)
589	Medicine Lodge River Reach 6	525 mg/l (Proposed)
588	Medicine Lodge River Reach 8, North Branch Medicine Lodge River, and Otter Creek	300 mg/l (Adopted)
732	Thompson Creek, and Soldier Creek	300 mg/l (Adopted); 250 mg/l (proposed)

## **2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT**

**Level of Support for Designated Use:** Not Supporting Attainable Domestic Water Supply

**Monitoring Sites:** Fixed- Station 220 near Kiowa, Station 588 near Belvidere, Station 732 on Thompson Creek

**Rotational- Station 589 near Medicine Lodge, Station 590 on Elm Creek near Medicine Lodge**

**Period of Record Used:** 1986 to 2005

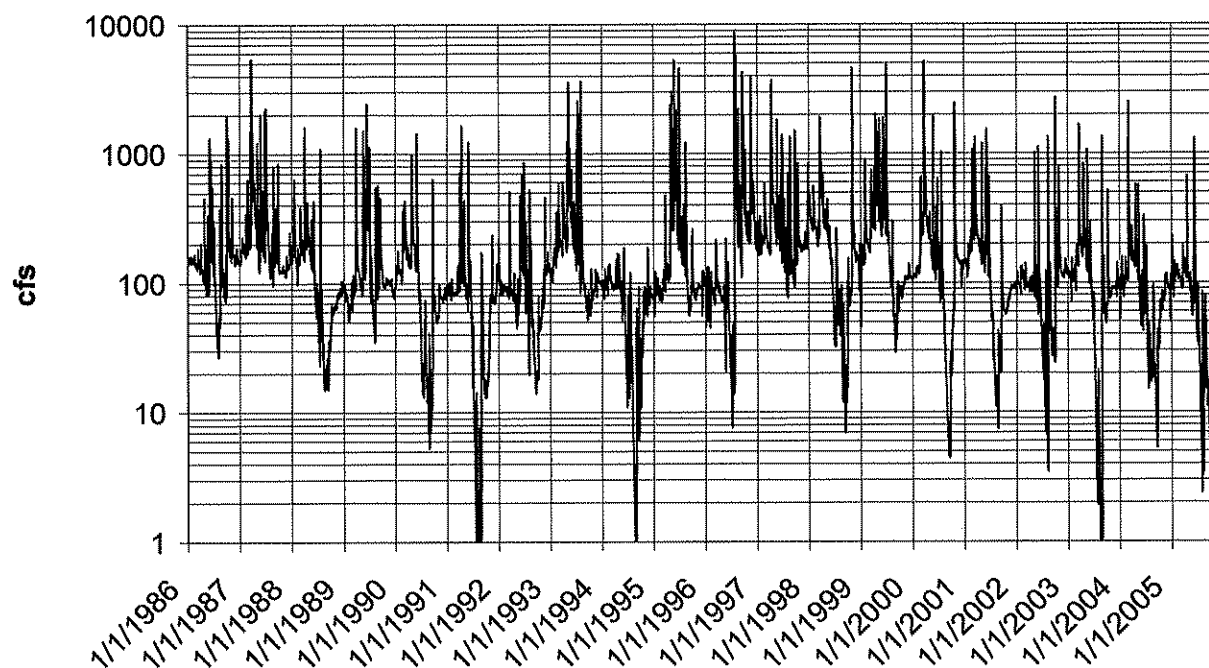
**Flow Record:** Medicine Lodge River near Kiowa (USGS Station 07149000; 1970-2005).

**Hydrology:** Table 3 shows significant contributions come from Elm Creek, Turkey Creek, Soldier Creek, and Thompson Creek. Most tributaries do not contribute much baseflow nor runoff. Figure 2 shows average daily flows at the USGS gaging station near Kiowa during the period of record.

**Table 3: USGS estimated flow and discharge**

Stream Name	USGS Segment	Drainage area	Avg. Flow	90%	75%	50%	25%	10%	2-year peak
Medicine Lodge River at State Line	5377	965.00	154.00	12.00	47.00	85.00	141.00	271.00	4030
Wilson Slough	5095	16.00	2.16	0.00	0.01	0.10	0.17	0.94	668
Antelope Cr	4940	12.40	1.13	0.00	0.00	0.00	0.01	0.01	572
Elm Cr	4903	183.00	27.70	1.42	5.71	11.10	20.40	40.20	1850
Amber Cr	4695	15.40	2.27	0.00	0.78	1.13	1.19	1.81	629
Crooked Cr	4647	15.20	1.76	0.00	0.20	0.30	0.37	0.68	611
Elm Cr, North	4616	34.80	4.49	0.00	0.52	1.25	2.00	4.12	683
Elm Cr, South	4631	75.50	9.59	0.02	1.24	2.72	5.16	10.80	967
Elm Cr, South E Br	4614	28.10	2.88	0.00	0.02	0.39	0.50	1.54	2300
Cedar Cr	5016	7.05	39.80	0.01	0.49	1.98	4.06	8.53	837
Medicine Lodge River at Medicine Lodge	4904	632.00	89.60	5.34	22.90	43.30	76.30	149.00	3000
Bitter Cr	4936	14.10	1.81	0.00	0.00	0.00	0.01	0.67	566
Little Bear Cr	4972	25.30	3.73	0.00	0.02	0.77	1.52	3.49	766
Sand Cr	4803	16.10	2.22	0.00	0.01	0.44	0.55	1.35	625
Medicine Lodge River at Turkey Creek	4723	314.00	36.60	1.32	7.58	14.90	27.60	54.20	1880
Puckett Cr	4830	16.00	1.84	0.00	0.01	0.01	0.01	0.52	580
Cottonwood Cr	4752	13.20	1.29	0.00	0.00	0.00	0.01	0.01	1450
Bear Cr	4834	36.00	4.79	0.01	0.36	1.48	2.68	5.21	787
Mulberry Cr	4728	22.10	2.59	0.00	0.16	0.70	0.87	1.76	708
Turkey Cr	4722	58.60	7.02	0.01	0.80	2.03	3.75	7.62	949
Soldier Cr	4575	84.40	8.79	0.04	1.82	3.27	5.49	10.20	1020
Medicine Lodge R, N Br	4544	26.30	1.97	0.00	0.00	0.00	0.02	0.52	1020
Otter Cr	4636	15.00	1.33	0.00	0.01	0.09	0.18	0.26	505
Thompson Cr	4547	79.20	7.54	0.02	0.83	2.17	4.05	8.13	1020

## Medicine Lodge River Flow at Kiowa



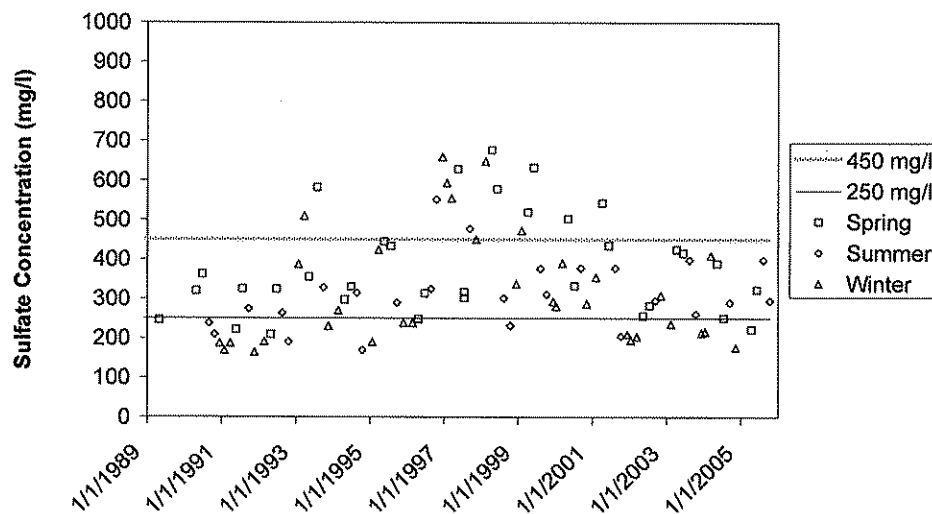
(Figure 2- Average Daily Flow at USGS gaging station 07149000)

**Current Conditions:** Sulfate concentrations at KDHE Stream Chemistry Monitoring Site 220 have ranged from 164 mg/l to 892 mg/l over the period of record, Table 4 and Figure 3. Overall, the average sulfate concentration was 358 mg/l. Concentrations at flows less than median flow averaged 297 mg/l, while those at higher flows averaged 470 mg/l. There are high natural background sulfate concentrations in the Medicine Lodge River. Excursions were seen in all three seasons defined by KDHE (Winter: November- March, Spring: April- July, Summer/Fall: August-October). Seventy-one percent of samples from water quality site 220 were over the criterion of 250 mg/l. Between 1996 and 2002 most flows in all seasons exceeded the criterion, possibly reflecting higher average discharge during that time. Since 2002 no samples collected have exceeded the adopted 450 mg/l criterion when flows tended to be lower on average.

**Table 4: KDHE measured sulfate levels in the Medicine Lodge Watershed**

Station	Period of Record	# of Samples	Avg. SO <sub>4</sub>	0-49% flow average SO <sub>4</sub>	Baseflow Avg.	Winter Avg.	Spring Avg.	Summer Avg.	# samples > 250	# samples >300	# samples >450	Maximum
220	1986-2005	77	358	410	276	322	310	400	69	54	19	892
589	1990, 1994, 1998, 2002	23	378	410	354	356	458	317	19	16	4	748
588	1990-2005	92	161	199	127	150	192	136	12	5	0	387
590	1990, 1994, 1998, 2002	21	37	36	40	34	40	37	0	0	0	52
732	2002-2005	23	16	16	17	16	15	18	0	0	0	23

### SC 220 Sulfate Concentration Over Time

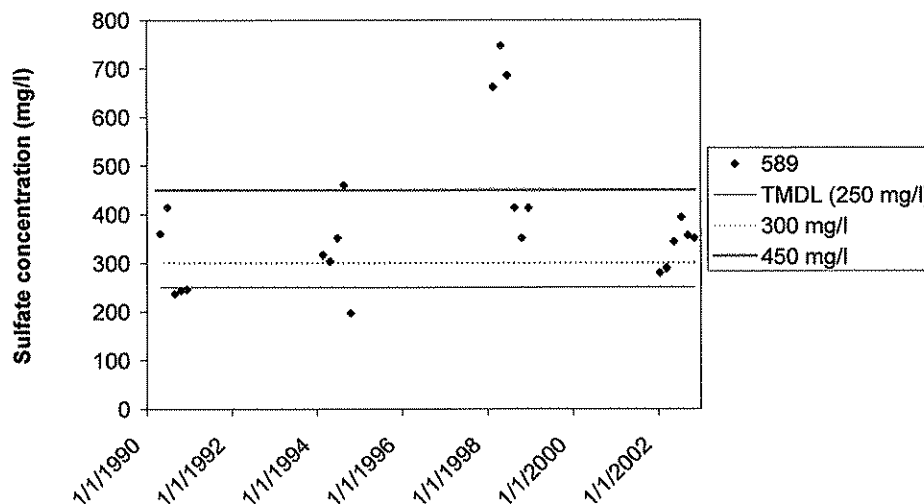


**(Figure 3 – Sulfate concentration at SC 220 as collected and measured by KDHE, with domestic water supply quality criterion (250 mg/l) and existing approved criterion (450 mg/l))**

Upstream monitoring at KDHE Stream Chemistry Monitoring Site 589 near the City of Medicine Lodge indicates the same pattern of exceedance with at least 75% of the samples taken in 1990, 1994, 1998 and 2002 greater than 250 mg/l, Figure 4. Data from KDHE Stream Chemistry Monitoring Site 588 on the main stem of the Medicine Lodge River show ongoing exceedance of water quality criterion, with 12 of 92 samples greater than 250 mg/l. Violations occurred during high flow events in all three seasons. Similar, though dampened, patterns emerge at the most upstream mainstem monitoring station, 588, Figure 5. The extended record at SC 588 indicates that while average concentrations cluster below 200 mg/l, during periods of greater discharge sulfate levels can exceed both the domestic water supply quality criterion, and the adopted water

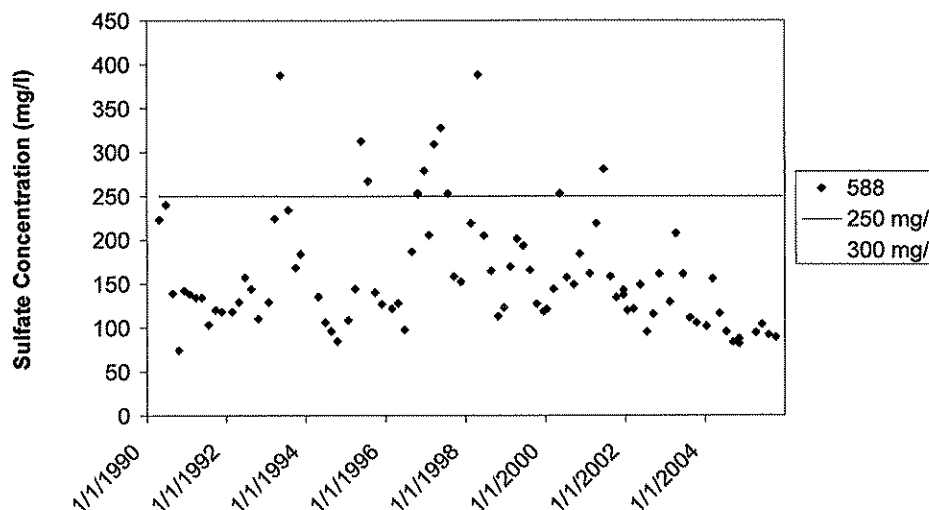
quality criterion (300 mg/l) for this station. No samples over 300 mg/l were recorded at this site between 2000 and 2005, a period of lower average flows than the preceding five years.

### SC 589 Sulfate Concentration Over Time



(Figure 4 – Sulfate concentration at SC 589 as collected and measured by KDHE, with existing domestic water quality criteria (250 mg/l), adopted upstream criteria (300 mg/l) and downstream adopted criteria (450 mg/l))

### SC 588 Sulfate Concentrations Over Time

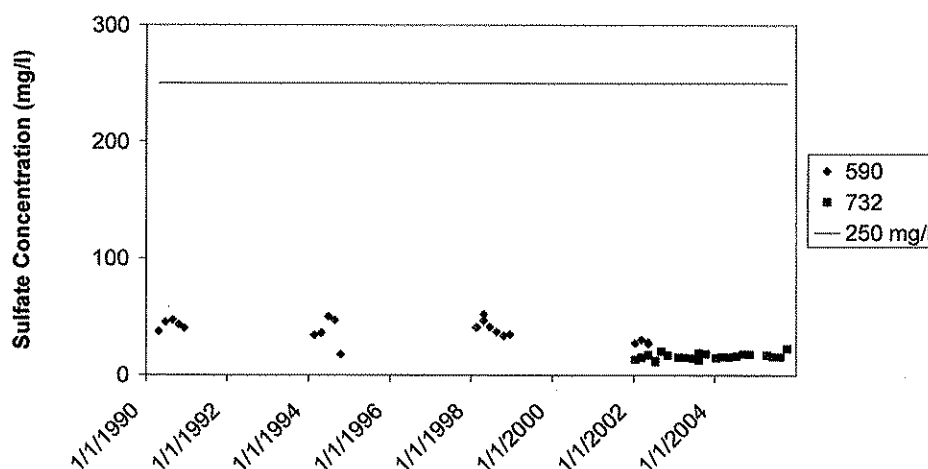


(Figure 5 – Sulfate concentration at SC 588 as collected and measured by KDHE, with existing domestic water quality criteria (250 mg/l), and existing adopted criteria (300 mg/l))

Monitoring stations on Elm Creek (590) and Thompson Creek (732) show low sulfate levels over

the period of record, 1990-2005, with concentrations rarely exceeding 50 mg/l, Figure 6. No violations of the domestic water supply quality criteria have ever been recorded at either location. These two stations drain areas on the northern side of the basin and reflect conditions that differ from those along the southern side of the basin and the middle segment of the mainstem of the Medicine Lodge River.

### SC 590 and SC 732 Sulfate Concentrations Over Time

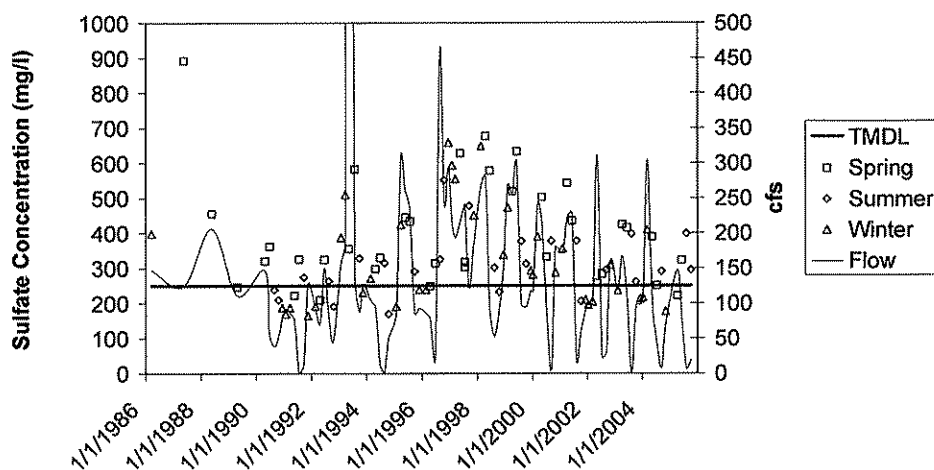


(Figure 6 – Sulfate concentration at SC 590 and SC 732 as collected and measured by KDHE, with existing domestic water quality criteria (250 mg/l))

Discharge is linked to the recorded sulfate concentrations, as discharge increases sulfate concentration increases, Figures 7, 8 and 9. A discernable break point occurs at flows exceeding 100 cfs, with sulfate concentrations rising dramatically thereafter. Even at flows less than 100 cfs, regular violations of the domestic water quality supply criteria, 250 mg/l, occur. No winter low flow samples were recorded, despite the prevalence of low flow events during winter. Thus, the bulk of low flow events in this watershed occur during the summer, Figure 2, when irrigation withdrawals and evapotranspiration reach peak levels. However, since sulfate concentrations peak during peak flows, low baseflow levels during the summer should not alter overall sulfate loads for the basin. Reduction in consumptive use of water in winter apparently allows flows to rebound from summer low levels.

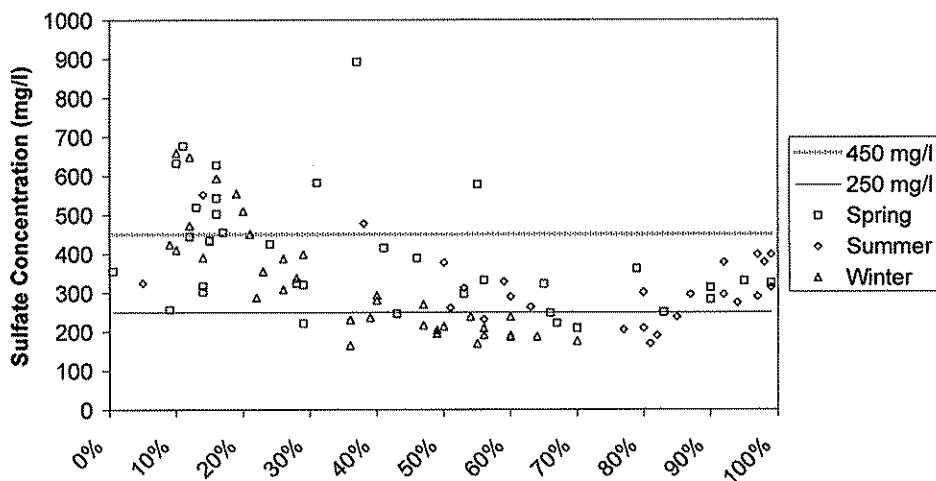


### SC220 Sulfate Concentration With Sampling Date Average Flow



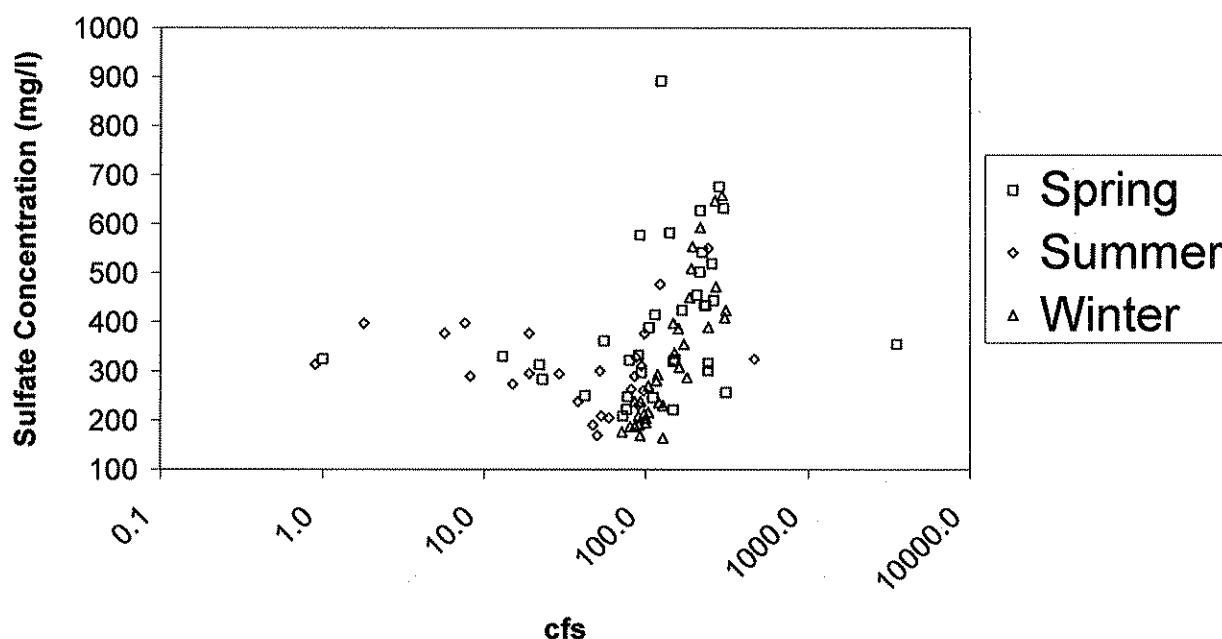
(Figure 7 – Mainstem sulfate concentrations with average daily flow in cubic feet per second on the day sample was collected, and displayed by season)

### SC 220 Sulfate Concentration By Flow Percentile



(Figure 8 – Mainstem sulfate concentrations by average daily flow percentile ranking for the day sample was collected, and displayed by season)

## SC220 Sulfate Concentration by Average Daily Discharge

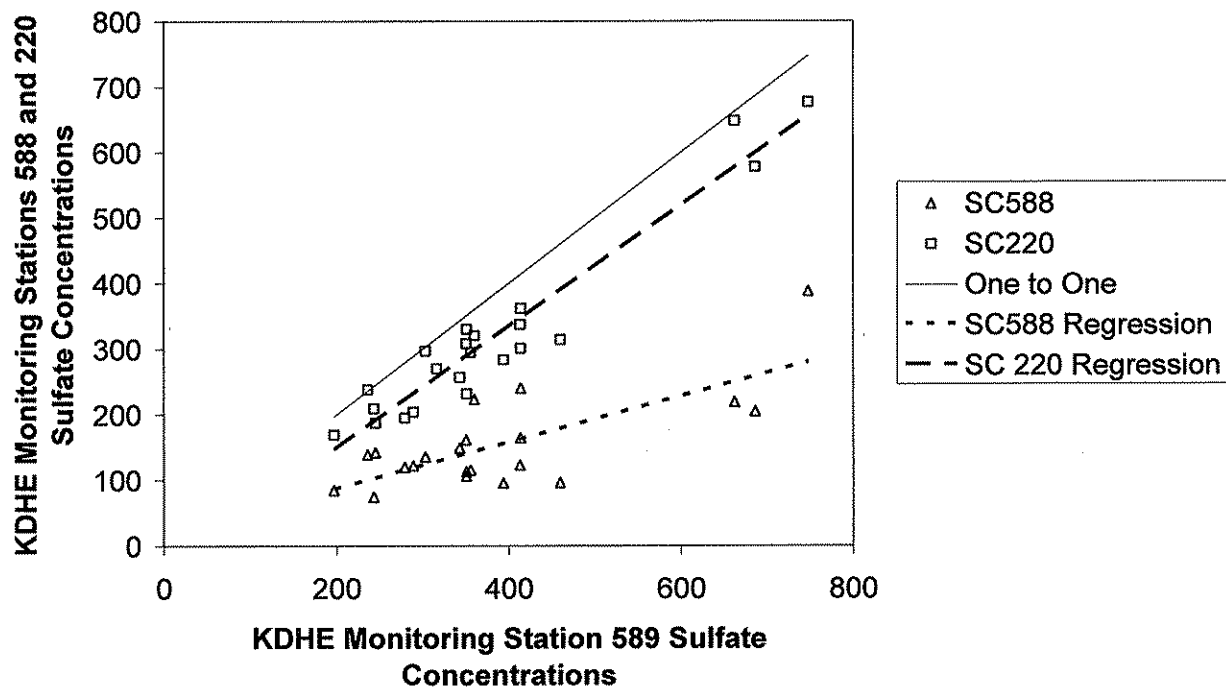


(Figure 9 – Mainstem sulfate concentrations by average daily flow in cubic feet per second for the day sample was collected, and displayed by season)

The bulk of the sulfate load appears to originate in the middle reach of the Medicine Lodge River, Figure 10. If the sulfate originated in the upper reaches of the watershed we would expect to see levels higher at station 588 than those at 589, as dilution would reduce concentrations with increasing discharge in the downstream direction. Instead, we observe that concentrations on same sampling dates at both the site upstream, 588, and downstream, 220, are lower than those at 589. This suggests that the loading is predominantly coming from the middle reach, and is diluted by the time that the water reaches station 220, possibly by water from Elm Creek.

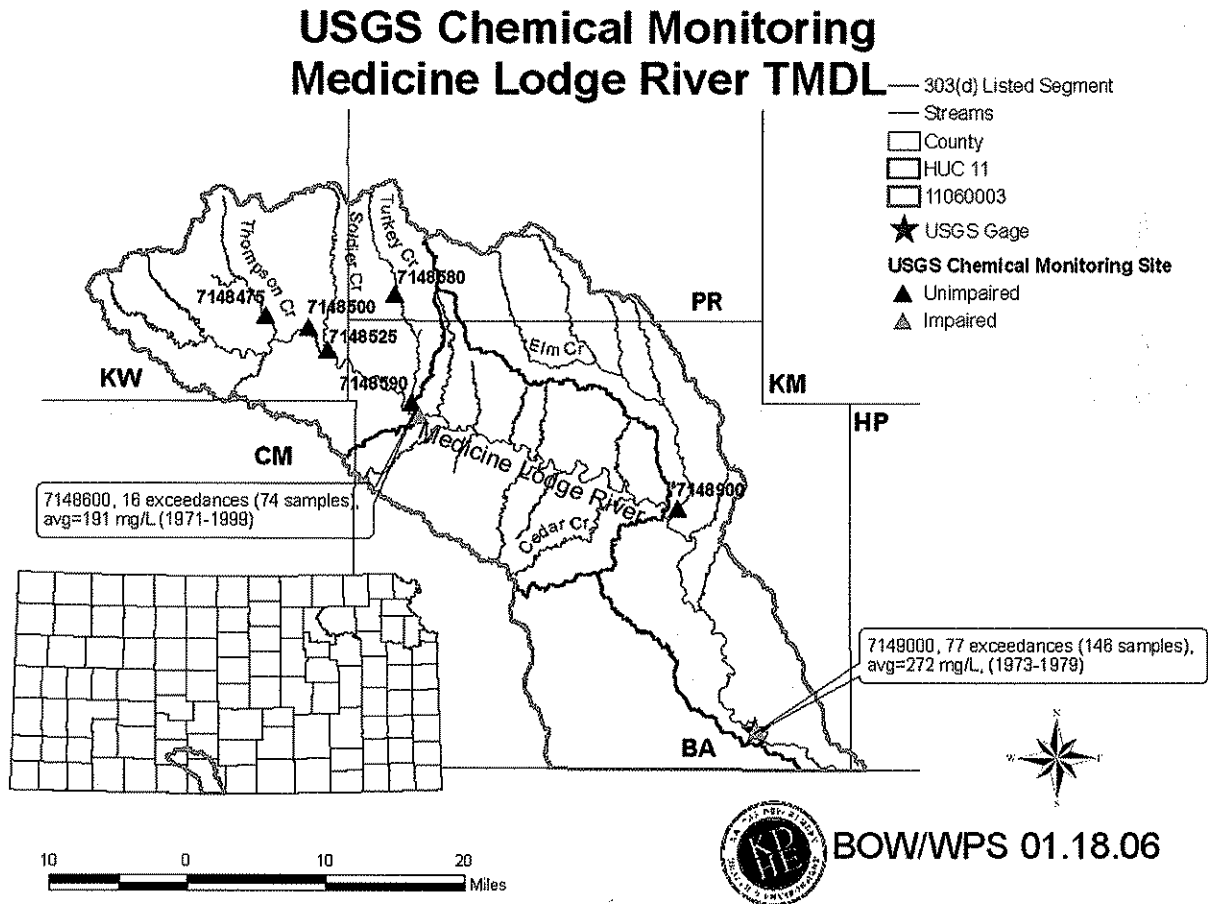
There is a strong regression relationship between 589 and 220 that suggests sulfates are diluted in the downstream direction, but are generated in the middle reach. A linear regression between 589 and 588 suggests that sulfates are much lower in the upper reach and any relationship between the two stations is the result of circumstance (coincidental wet weather loading). Station 588 does not affect the concentrations seen at 589 to any great degree.

## KDHE Sulfate Cross-Site Comparison



(Figure 10 – Cross site comparison of mainstem Medicine Lodge River monitoring stations)

Further support for this conclusion is offered by monitoring data collected by the US Geological Survey, Figure 11 and Table 5. Domestic water supply criteria excursions occur along the mainstem of the Medicine Lodge River, and do not reflect significant sulfate loading from the northern tributaries, even when, as with Turkey Creek, the tributary drains a relatively large area and has multiple sampling stations along the reach.



(Figure 11 – USGS chemical monitoring sites within the Medicine Lodge River basin)

**Table 5: USGS measured sulfate levels in the Medicine Lodge Watershed**

Stream Name	Station	Period of Record	# of samples	Average	Maximum	# of samples >250	# of samples >300	# of samples >450
Thompson	07148475	1988-1992	16	35	57	0	0	0
Spring	07148500	1988-1992	16	30	38	0	0	0
Soldier	07148525	1988-1991	13	53	360	1	1	0
Upper Turkey	07148580	1971-1978	19	14	30	0	0	0
Lower Turkey	07148590	1988-1992	16	57	83	0	0	0
Medicine Lodge River, at Sun City	07148600	1971-1999	74	191	443	16	7	0
Elm Creek	07148900	1962-1971	13	39	119	0	0	0
Medicine Lodge River, at Kiowa	07149000	1973-1979	146	272	510	77	57	2

**Desired Endpoints of Water Quality (Implied Load Capacity) over 2006 - 2010:**

Existing background concentrations shall be maintained at stations 220 (450 mg/l) and 588 (300

mg/l). The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Drinking Water Use, 250 mg/l, for segments that are naturally able to meet this standard. This TMDL will, however, be staged. Background concentrations are detailed below and summarized in Table 6.

The middle reach of the Medicine Lodge River is subject to loading of sulfate from underlying Permian geologic formation and their high gypsum content in the watershed. As such, the segment above station 589 has elevated sulfate levels from this natural source, with a tendency to increase loading with flow. This natural background of sulfate at high flows, consistently above 250 mg/L, makes achievement of the Standard impossible at high flows. An alternative endpoint for high flows is needed, however.

Kansas Implementation Procedures for Surface Water allow for a numerical criterion based on natural background to be established. The specific stream criteria to supplant the existing criteria will be developed concurrent with Stage One of this TMDL following the appropriate Water Quality Standards Process. The limited data for station 589 produce an average sulfate of 375 mg/l for similar conditions seen at station 220 and 588 when the background concentrations were established. However, concurrent sampling and regression analysis, Figure 10, indicates sulfates above station 589 influence those seen at 220, after dilution has occurred from Elm Creek. Therefore, the corresponding endpoint at 589 to the background concentrations at 220 of 450 mg/l is 525 mg/l.

The stream segments monitored by stations 590, Elm Creek, and 732, Thompson Creek, currently exhibit low sulfate levels. Because these streams are currently meeting water quality standards, and because Thompson Creek is an exceptional state water, we will maintain the current domestic water supply criteria, 250 mg/l, as the desired endpoint for these segments. This will require a revision to the WQS for Thompson Creek.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated sulfate levels. Achievement of the endpoints will indicate that water quality standards have been attained and full support of the designated uses of the stream has been restored.

**Table 6: Background concentrations at KDHE monitoring sites in the Medicine Lodge River Basin**

Station	Stream	Background concentration or water quality standard
220	Lower Medicine Lodge River	450 mg/l (Adopted)
588	Upper Medicine Lodge River	300 mg/l (Adopted)
589	Middle Medicine Lodge River	525 mg/l (Proposed)
590	Elm Creek	250 mg/l (Existing)
732	Thompson Creek	250 mg/l (Revised)

### 3. SOURCE INVENTORY AND ASSESSMENT

**Land Use:** The Kansas GAP dataset was used to assess land use patterns. Most of the watershed is native grassland (55%) and cropland (27%), Figure 12. Appropriation of water and actual water use is mostly from groundwater. Groundwater source irrigation in the watershed used 16253 acre feet during 2003, the most recent year for which data are available. Consumption of groundwater for irrigation may impact sulfate levels in the mainstem of the Medicine Lodge River by reducing total dilution during summer months when peak irrigation withdrawals are made.

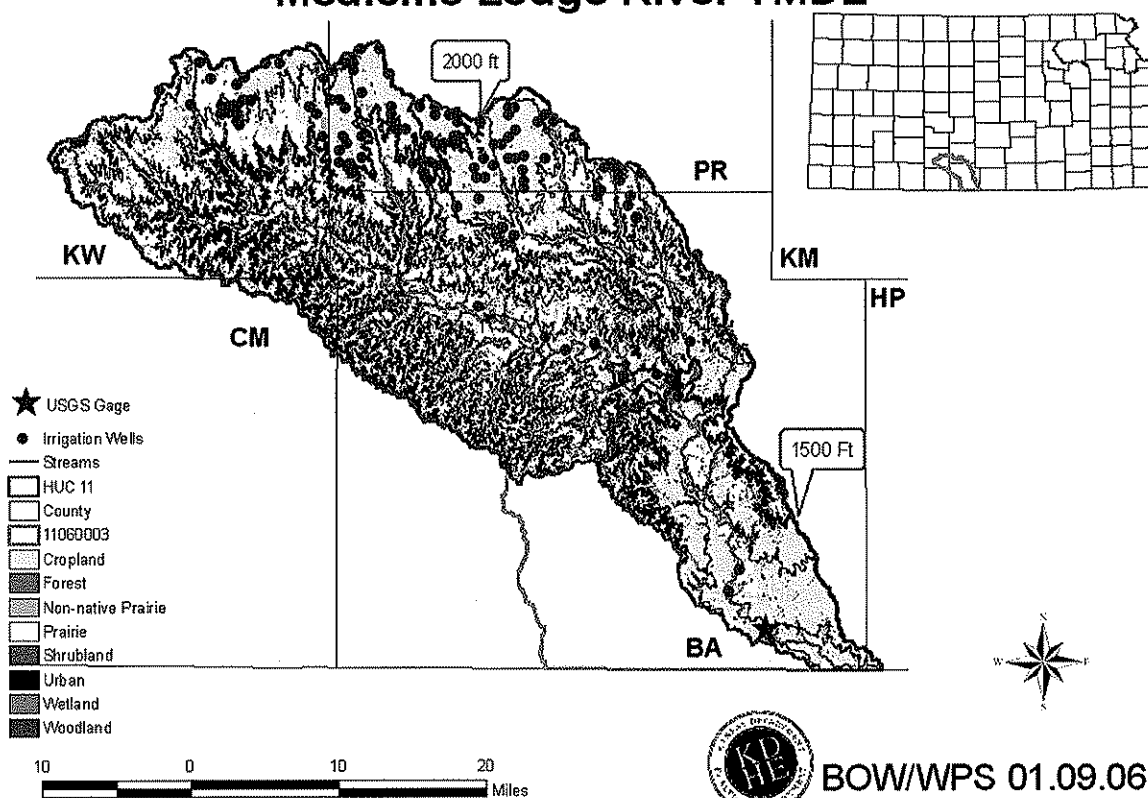
Elm Creek, as an example, discharges an estimated 20,000 acre feet of water each year. In 2003 irrigators withdrew 8253 acre feet of water, more than 40% of the estimated annual discharge of Elm Creek. If the groundwater diversions increase infiltration by drawing down the water table and reducing baseflow, the low sulfate water from this tributary will not be available to provide dilution for the mainstem. Because most of the irrigation activity is located in the northern portion of the basin, which is also the area with the lowest sulfate loads, the reduction of available low sulfate water for dilution may be a factor influencing concentrations leading to higher sulfate levels during summer months, Table 6.

Groundwater is also used for municipal supply, but no municipal rights to surface water exist within the basin. The chief groundwater use is associated with the subwatersheds containing Elm Creek and Turkey Creek along the Barber County/Pratt County border. Appropriations are made for industry, irrigation, municipalities, and others.

**Table 7: Seasonal baseflow at mainstem monitoring stations**

Station	Summer Baseflow Average	Winter Baseflow Average
220	290 mg/l	200 mg/l
589	322 mg/l	245 mg/l
588	121 mg/l	125 mg/l

## 100 ft. Contours, Irrigation and Land Cover Medicine Lodge River TMDL



(Figure 12 – Land use and groundwater irrigation diversions in the Medicine Lodge basin. 100 ft. contour lines are included for landscape relief context. Areas of high relief are concentrated in the middle section of the basin, where the predominant land use is prairie, native and nonnative.)

**Irrigation Return Flows:** No impairment is associated with irrigation return flows off lands with flood irrigation. There is little irrigation in the watershed due to the prevalence of bedrock at or near the surface and the thin saturated thickness of unconsolidated sediments that are present. Most of the irrigation within the overall Medicine Lodge basin is located at the Barber County/Pratt County border, associated with the southern extent of the Big Bend Prairie Aquifer in the headwaters of Elm Creek and Turkey Creek. Any return flows from those diversions would be low in sulfate because of the low sulfate content of the Big Bend Prairie Aquifer and as confirmed by samples taken on Elm Creek (sulfate average of 40 mg/l) and Turkey Creek (sulfate average of 57 mg/l). Remaining irrigation is along the main stem of the river and some surface rights on headwater tributaries above Belvidere, but generally, those rights have not recently pumped water.

**Geology:** Donald Whittemore, Senior Scientist and Section Chief of the Geohydrology Unit at the Kansas Geologic Survey was consulted to ascertain the geologic influences on the sulfate levels in the Medicine Lodge River basin, Figure 13. His report follows,

"The primary cause of the sulfate impairment of the Medicine Lodge River and Mule Creek in Kiowa, Comanche, and Barber Counties is natural dissolution of gypsum in the bedrock outcropping and underlying alluvial aquifer sediments in the watersheds. Any anthropogenic sulfate sources or hydrologic modifications increasing the sulfate concentration would be minor in comparison with the natural sulfate source in the watersheds.

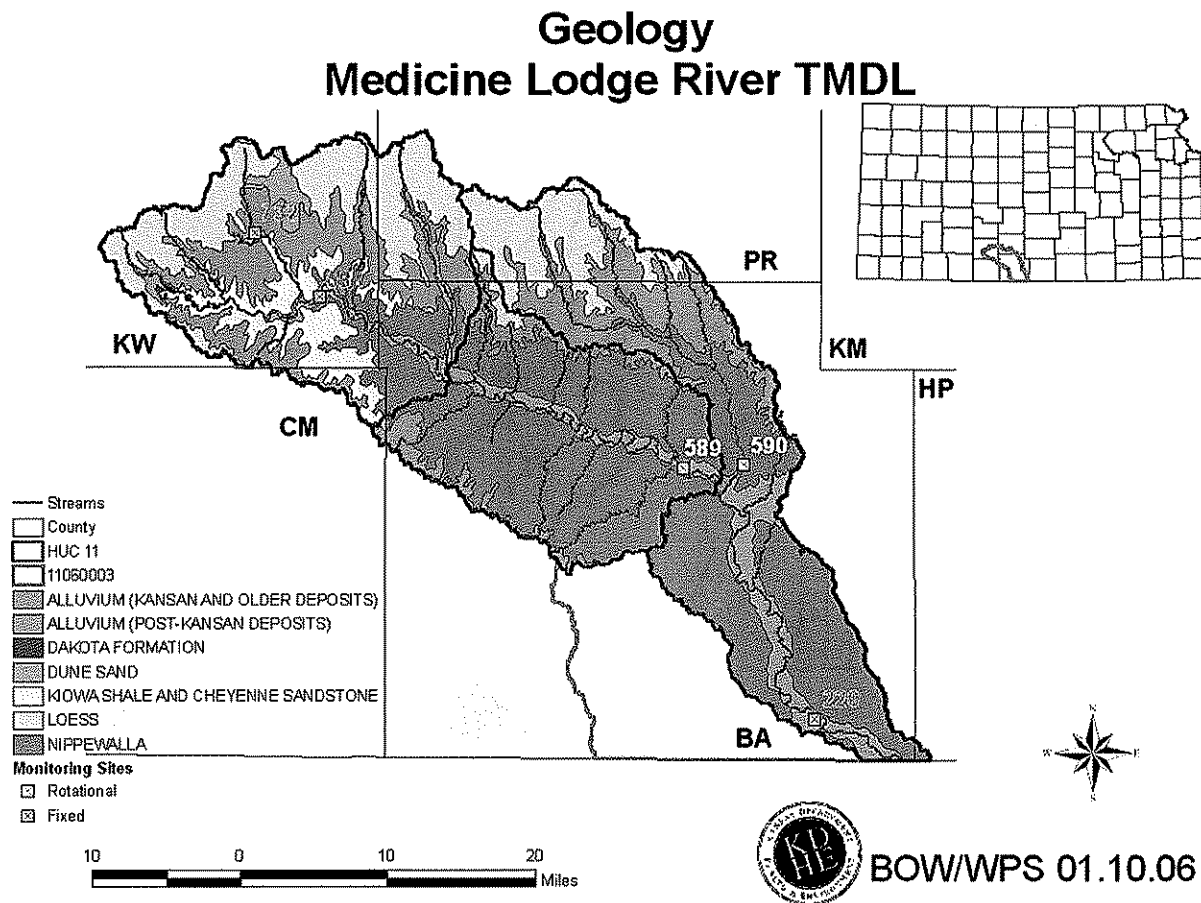
#### Source of Sulfate

Bedrock outcropping and underlying alluvial sediments of the watershed of the upper Medicine Lodge River in Kiowa County (Segment 8, water-quality monitoring station 588 near Belvidere) consists primarily of shales, siltstones, and sandstones of the Cretaceous System. Most of the Cretaceous bedrock that would affect the quality of runoff and ground-water discharge to the tributaries and mainstream of the river is the Lower Cretaceous Kiowa Shale and Cheyenne Sandstone. Gypsum (hydrated calcium sulfate), in the mineral form known as selenite, occurs in these formations. The selenite is present in different parts of the Cheyenne Sandstone and is common throughout the Kiowa Shale. Gypsum is a very soluble mineral and can lead to sulfate concentrations of nearly 2,000 mg/L when dissolved to saturation in ground water. The sulfate concentration ranged from 97 to 748 mg/L in water of the Medicine Lodge River near Belvidere during 1996-1998 while the range in chloride conduct was 45-129 mg/L. The high sulfate/chloride ratio and the prevalence of gypsum in the bedrock fit the natural dissolution as the predominant source of mineralized water in the river. Oil-field brines have very low sulfate/chloride ratios in Kansas and could not be a significant source of sulfate based on the water chemistry of the Medicine Lodge River. There is little irrigation in the watershed due to the prevalence of bedrock at or near the surface and the thin saturated thickness of unconsolidated sediments that are present. Therefore, there is very little effect on the sulfate content of the river water that could be attributed to irrigation.

Bedrock outcropping and underlying alluvial sediments of the watershed of the lower Medicine Lodge River in Barber County (Segment 2, water-quality monitoring station 220 near Kiowa) consists of primarily of shales, siltstones, and sandstones of the Permian System. These include strata in the Upper Permian and upper part of the Lower Permian Series, including the Dog Creek Shale, Blaine Formation, Flowerpot Shale, Cedar Hills Sandstone, and Salt Plain Formation, all of which contain gypsum beds, veins, or cement. The Blaine Formation contains gypsum beds of great enough thickness that they are mined in Barber County. The prevalence of gypsum at or near the land surface in Barber County contributes substantial amounts of sulfate to runoff and ground-water discharge to streams as a result of natural dissolution of the mineral. The sulfate concentration ranged from 190 to 676 mg/L in water of the Medicine Lodge River near Kiowa during 1995-1998 while the range in chloride content was 44-141 mg/L. The high sulfate/chloride ratio and the prevalence of gypsum in the bedrock fit the natural dissolution as the predominant source of mineralized water in the river. Although oil-brine contamination of ground water in Elm Creek valley northeast of Medicine Lodge was documented in the 1940's, the brines could not be a significant source of sulfate in the river water because the brines have very low sulfate/chloride ratios in the area. There is little irrigation in the



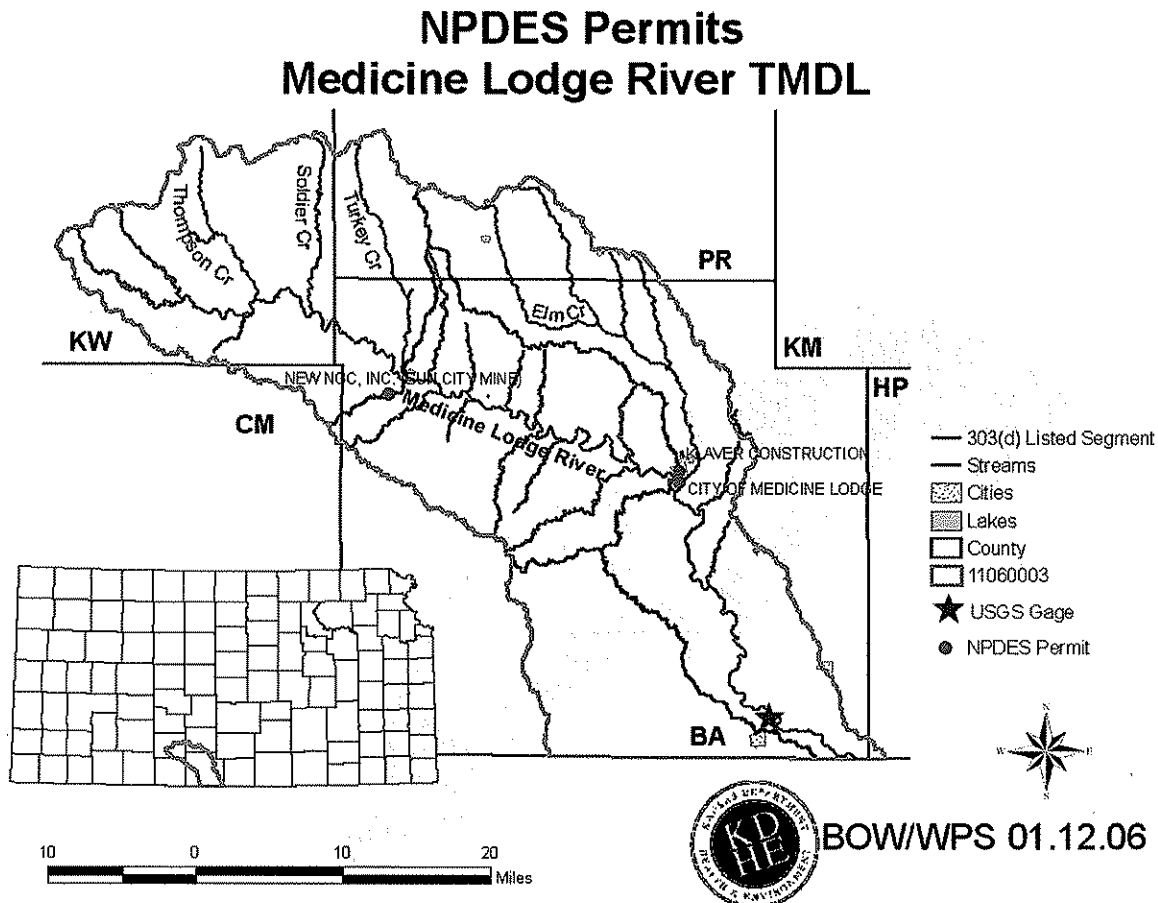
watershed due to the prevalence of bedrock at or near the surface and the thin saturated thickness of unconsolidated sediments that are present. Therefore, there is very little effect on the sulfate content of the river water that could be attributed to irrigation.”



(Figure 13 – Near surface geology in the Medicine Lodge River basin)

**NPDES:** There are three NPDES permitted wastewater dischargers located within the watershed, Table 7, Figure 14. One of them, the New NGC - Sun City Mine, has no recorded discharge during its permit history. A second facility, the City of Medicine Lodge, is not required to collect sulfate data as part of its permit requirements, and has only tested for sulfate once (66.1 mg/l, well below the level of concern). Medicine Lodge is authorized to withdraw water for municipal use from groundwater in the low sulfate Elm Creek basin. Source water data record concentrations ranging between 35-62 mg/l between 1995 and 2004. The City of Medicine Lodge wastewater will not likely contribute sulfate concentrations at levels of concern. The remaining point source, Klaver Construction, is located near the confluence of Elm Creek and the Medicine Lodge River. Permit records indicate that this site sporadically discharges 400-500 gallons

during infrequent spills from its settling basin, with a load of less than 2.7 pounds of sulfate per day. Based on the monitoring data this point source contribution to the sulfate loading at the monitoring site appears to be minimal.



(Figure 14 – NPDES permitted dischargers in the Medicine Lodge Basin.)

**Table 7: NPDES permitted dischargers in the Medicine Lodge Basin.**

Facility	NPDES #	KS Permit #	Receiving Stream	Design Flow (MGD)	Average Sulfate Concentration
City of Medicine Lodge	KS011685	M-AR60-0001	Elm Creek	0.35	66.1 mg/l
Klaver Construction – Concrete Delivery Vehicle Wash Basin	KSG110099	I-AR60-PR01	Medicine Lodge River	Settling Basin	650 mg/l
New NGC (Sun City Mine)	KS0092495	I-AR86-PO01	Medicine Lodge River	Settling Basin	No recorded discharge

**Contributing Runoff:** The watershed's average soil permeability is 2.5 inches/hour according to NRCS STATSGO data base. About 52% of the watershed produces runoff even under relative low (1.5 inches/ hr) potential runoff conditions. Under very low (<1 inches/ hr) potential conditions, this potential contributing area is almost halved (26%). Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing

less than 0.5 inch/ hr of rain will generate runoff from only 3% of this watershed, chiefly along the stream channels.

#### 4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The source assessment has ascertained that natural sulfate loading within the watershed generally is responsible for the excursions seen at Kiowa.

**Point Sources:** A Wasteload Allocation (WLA) of 300 pounds per day will be established for the City of Medicine Lodge wastewater treatment plant. In accordance with the background concentration of 450 mg/l, an average WLA of 1.9 pounds per day will be established for Klaver Construction. Because Klaver discharges sporadically, this WLA allows for spills of 500 gallons per day at higher concentrations occasionally as long as there are sufficient days of no discharge. As an example, if the average concentration is 650 mg/l, 500 gallon spills could occur on less than 70% of the days in any given month. A WLA of 0 pounds per day will be established for New NGC (Sun City Mine). Should future point sources be proposed in the watershed and discharge into the impaired segments, the current wasteload allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers.

**Non-Point Sources:** The elevated sulfate concentrations appear to stem from drainage of Permian geologic formations during high flows. The Load Allocation (LA) based on the existing standards will be established for each station as outlined in Table 8. These values will apply to flows at or below the 90%, 50% and 10% exceedance flow events, as estimated using USGS estimated flow data.

**Defined Margin of Safety:** The existing water quality criteria of 250 mg/l remains on Elm Creek or other northern tributaries of the Medicine Lodge River, and no waste load allocation applies to these streams, reflecting the lack of discharges into these streams. Continuous discharges to the Medicine Lodge River, such as by the City of Medicine Lodge, will be lower than established background levels. The margin of safety for the mainstem is reflected in the background concentrations calculations, taken as an average during moderate runoff events, rather than extreme values seen during exceptional high flow events.

**Table 8: Sulfate Load in tons per day at each KDHE monitoring station based on USGS estimated flow data.**

Station	Concentration (mg/l)	Load at 90% flow (tons/day)	Load at 50% flow (tons/day)	Load at 10% flow (tons/day)	90% flow (cfs)	50% flow (cfs)	10% flow (cfs)
220	450	26.73	119.07	351.135	22	98	289
590	250	0.9585	7.4925	27.135	1.42	11.1	40.2
589	525	6.5772	53.72325	185.6925	4.64	37.9	131
588	300	0.1134	5.5809	22.437	0.14	6.89	27.7
732	250	0.00675	0.324	1.14075	0.01	0.48	1.69

**State Water Plan Implementation Priority:** Because it appears this watershed's sulfate load is predominately natural, this TMDL will be a Low Priority for implementation.

**Unified Watershed Assessment Priority Ranking:** This watershed lies within the Medicine Lodge subbasin (HUC 8: 11060003) with a priority ranking of 49 (Low Priority for restoration).

**Priority HUC 11s:** Because of the natural geologic contribution of this impairment, no priority subwatersheds or stream segments will be identified.

## **5. IMPLEMENTATION**

### **Desired Implementation Activities**

1. Monitor any anthropogenic contributions of sulfate loading to river.
2. Establish alternative background criterion
3. Assess likelihood of river being used for domestic uses.

### **Implementation Programs Guidance**

#### **Non-Point Source Pollution Technical Assistance - KDHE**

- a. Evaluate any potential anthropogenic activities which might contribute sulfate to the river as part of an overall Watershed Restoration and Protection Strategy.

#### **Water Quality Standards and Assessment - KDHE**

- a. Establish background levels of sulfate for the stream segment 6 using data from Station 589 (525 mg/l).
- b. Reduce the criteria for Thompson and Soldier Creeks back to 250 mg/l.

#### **Use Attainability Analysis - KDHE**

- a. Consult with Division of Water Resources on locating existing or future domestic points of diversion on the Medicine Lodge River for drinking water purposes.

**Time Frame for Implementation:** Development of a background level-based water quality standard should be accomplished with the 2007 water quality standards revision.

**Targeted Participants:** Primary participants for implementation will be KDHE.

**Milestone for 2011:** The year 2011 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, additional monitoring data from Medicine Lodge River will be reexamined to confirm the impaired status of the river and the suggested background concentration. Should the case of impairment remain, source assessment, allocation and implementation activities will ensue.

**Delivery Agents:** The primary delivery agents for program participation will be the Kansas Department of Health and Environment.

### **Reasonable Assurances**

**Authorities:** The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.
2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
3. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.
4. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.
5. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.
6. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.
7. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.
8. The *Kansas Water Plan* and the Lower Arkansas Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

**Funding:** The State Water Plan Fund annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs

supporting water quality protection. This watershed and its TMDL are a Low Priority consideration and should not receive funding.

**Effectiveness:** Minimal control can be exerted on natural contributions to loading.

## **6. MONITORING**

KDHE will continue to collect bimonthly samples at Station 220, 588, 589, 590, and 732 including sulfate samples over each of the three defined seasons during the period of 2006-2011. Based on that sampling, the status of 303(d) listing will be evaluated in 2012 including application of numeric criterion based on background concentrations at high flows. Should impaired status remain, the desired endpoints under this TMDL will be refined and direct more intensive sampling will need to be conducted under specified seasonal flow conditions over the period. Background concentrations will be assessed as the average concentration taken during high flow events (those that exceed median flow).

## **7. FEEDBACK**

**Public Meetings:** Public meetings to discuss TMDLs in the Lower Arkansas River Basin were held June 7, 2006 in Hutchinson. An active Internet Web site was established at <http://www.kdheks.gov/tmdl/> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Lower Arkansas River Basin. A draft of this TMDL has been maintained on the website since March 1, 2006 and modifications to the original draft have been available to the public for viewing and review up to the date of submitting this TMDL to EPA.

**Public Hearing:** A Public Hearing on the original draft of these TMDLs of the Lower Arkansas River Basin was held in Hutchinson on June 7, 2006. The public comment period was open until June 20, 2006. No comments were received by KDHE.

**Basin Advisory Committee:** The Lower Arkansas River Basin Advisory Committee met June 7, 2006 to discuss the TMDLs in the basin. The Committee recommends approval of the Basin Plan that sets high priority TMDLs in the basin, thereby, delegating medium and low priority status to this and subsequent TMDLs for the basin.

**Milestone Evaluation:** In 2011, evaluation will be made as to the degree of impairment which has occurred within the drainage and current condition of Medicine Lodge River. Subsequent decisions will be made regarding implementation approach and follow up of additional implementation.

**Consideration for 303(d) Delisting:** Medicine Lodge River will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2006-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be

made to the applicable criterion during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities might be adjusted accordingly.

**Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process:** Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2006 which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2007-2011

Revised June 28, 2006